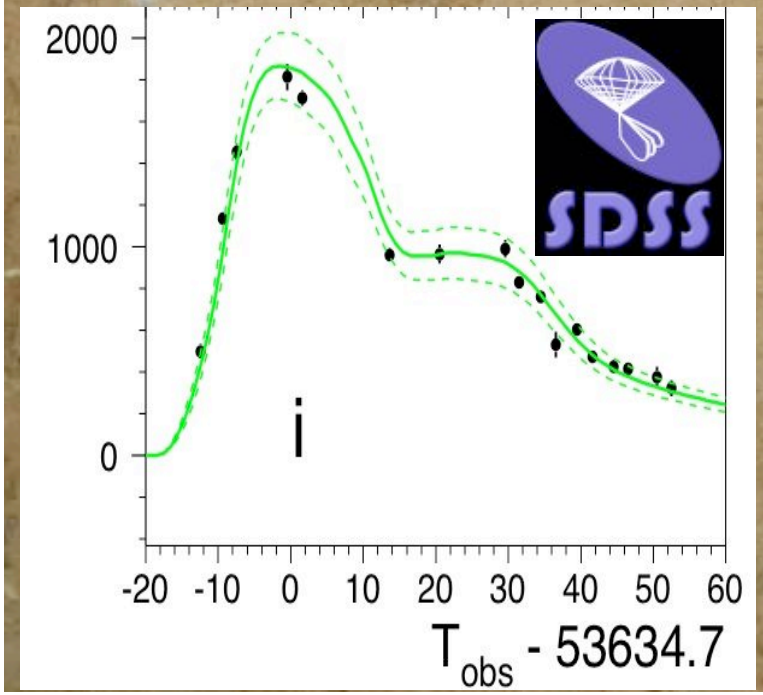
Kavli Institute
for Cosmological Physics
AT THE UNIVERSITY OF CHICAGO

Cosmology Results from the SDSS-II Supernova Survey



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Jan 5, 2009

AAS 213

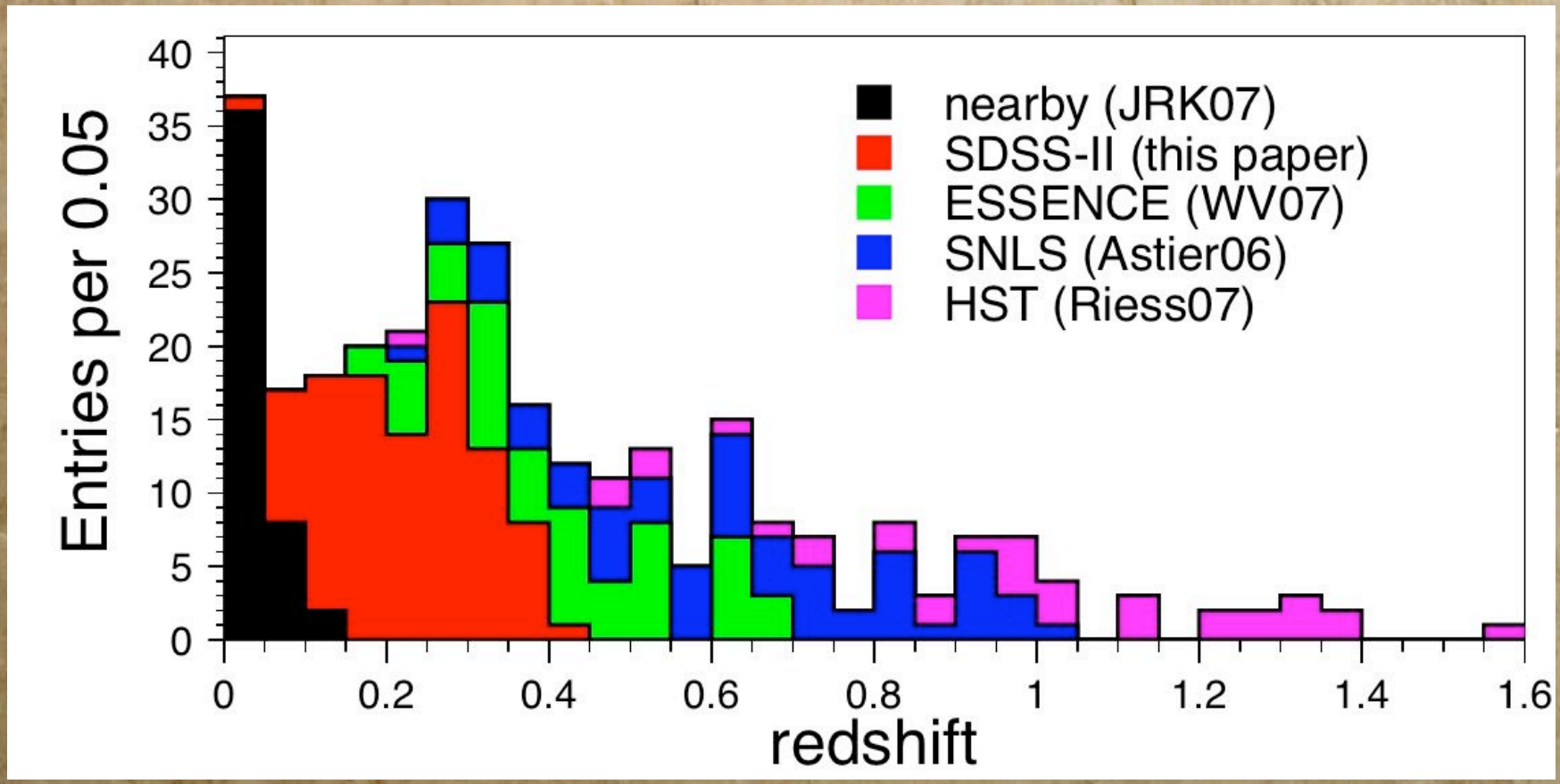
Long Beach, CA

The SDSS-II SN Survey

- 300 deg^2 rolling search for SNe in the Fall seasons of 2005 -2007 (9 months total on SDSS 2.5m)
- Spectroscopic confirmation for ~500 SN Ia (using ~dozen telescopes)
- Host-galaxy redshifts for ~300 photometrically ID'ed SNe Ia
- ~1700 photometric SN Ia remain; host-redshifts still in progress (spec-proposal submitted to SDSS-III)
- This talk: cosmology results using 103 SNe (after cuts) from first season (Fall 2005).

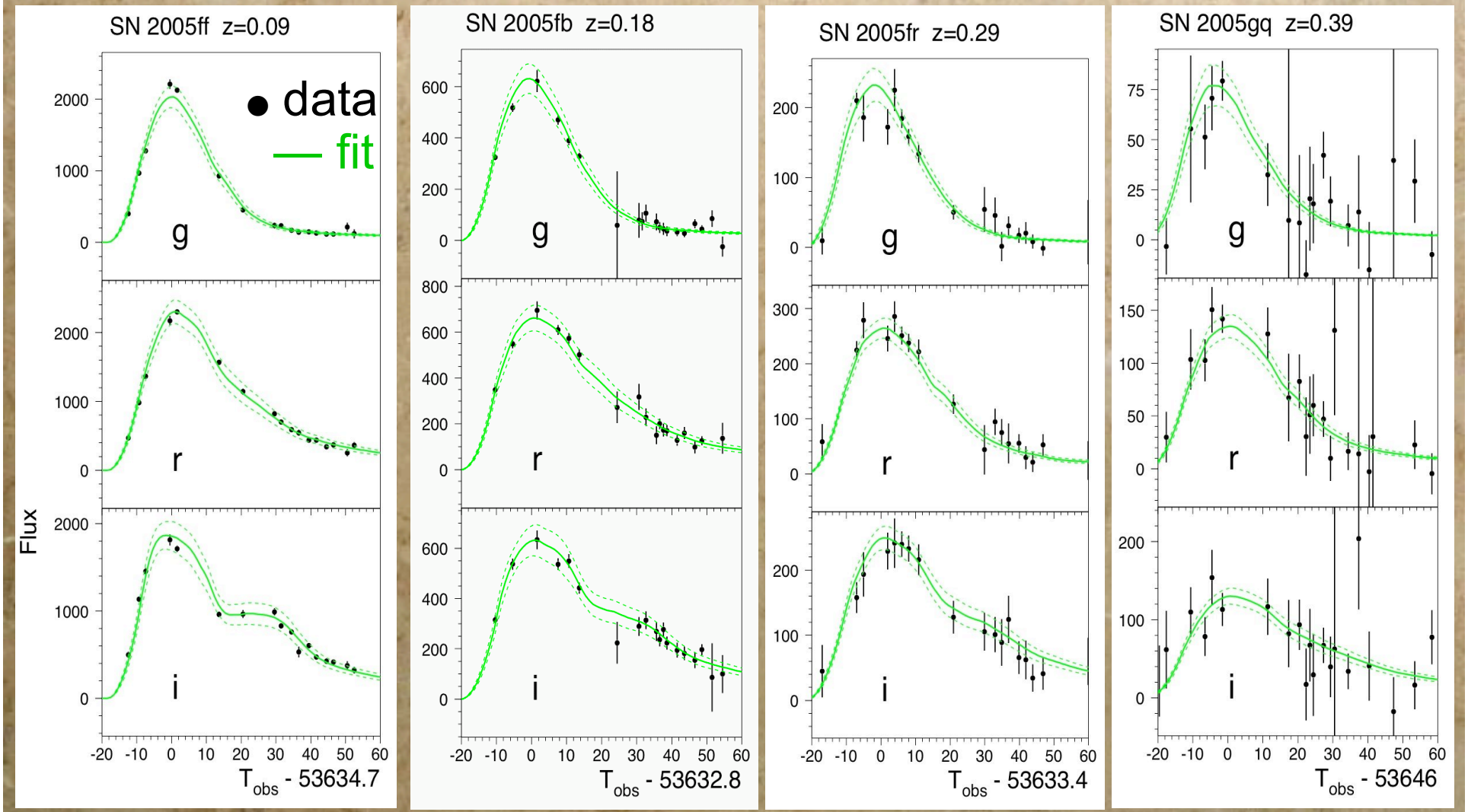
Redshift Distribution

(SDSS SNe fill redshift gap: 0.05 - 0.4)

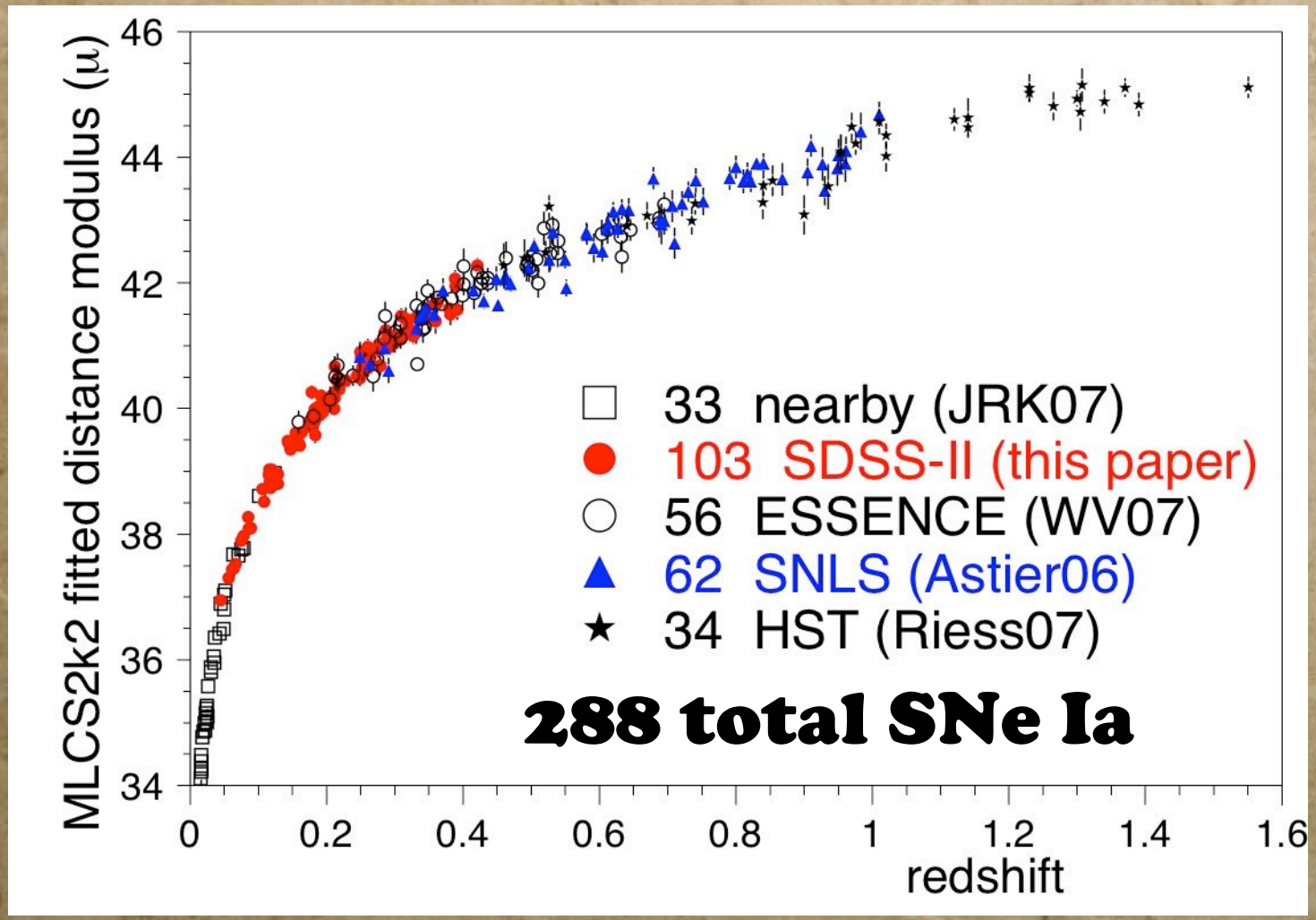


SDSS **gri** Light Curves:

$\langle N_{MEASURE} \rangle = 48$ per SN



Combine SDSS SNe with Published Samples

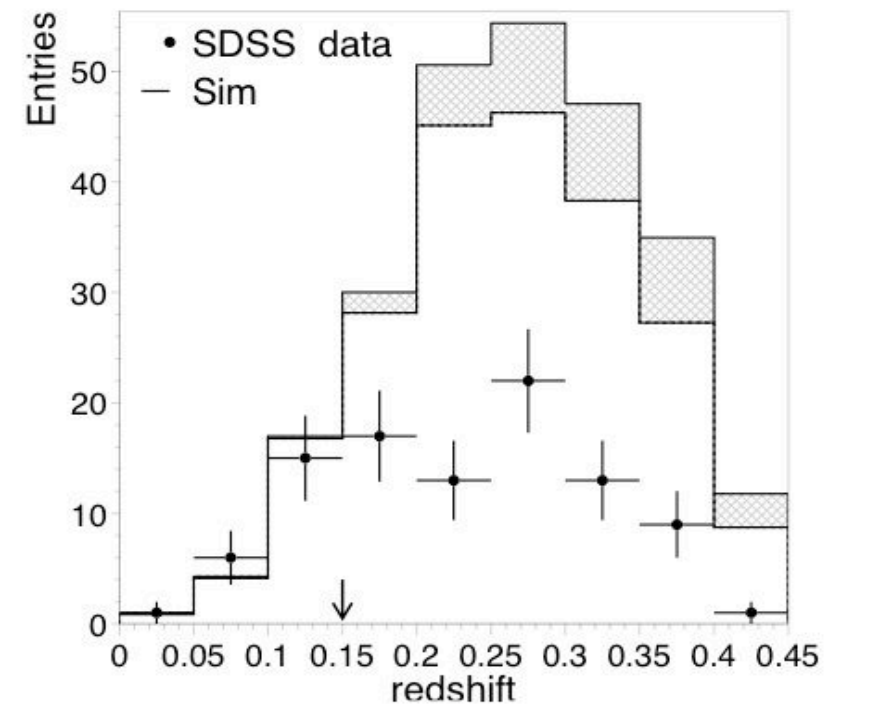


Analysis with available light curve fitters:

- **MLCS (Jha,Riess,Kirshner 2007):**
  same method, but re-written with significant improvements to implementation

- **SALT2 (Guy et al.,2007):**
  use code as-is, but retrained spectral surfaces with our UBVRI filter shifts (instead of those in Astier 2006)

Measurement of Dust Properties with SDSS-II

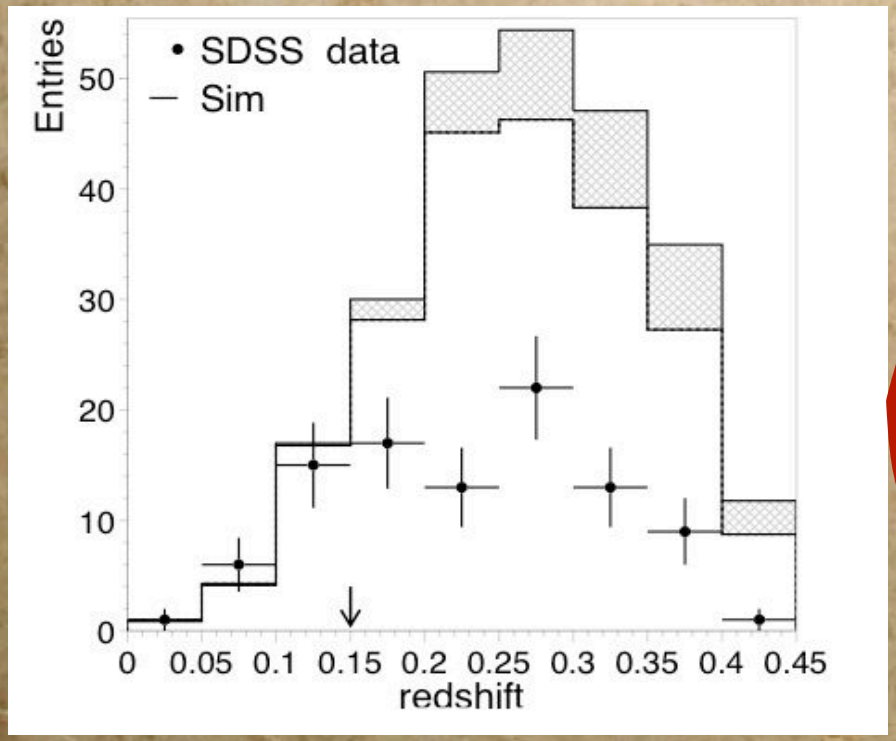


MLCS framework

PROBLEM: Spec-confirmed SN Ia sample has large (spectroscopic) inefficiency that is not modeled by the simulation.

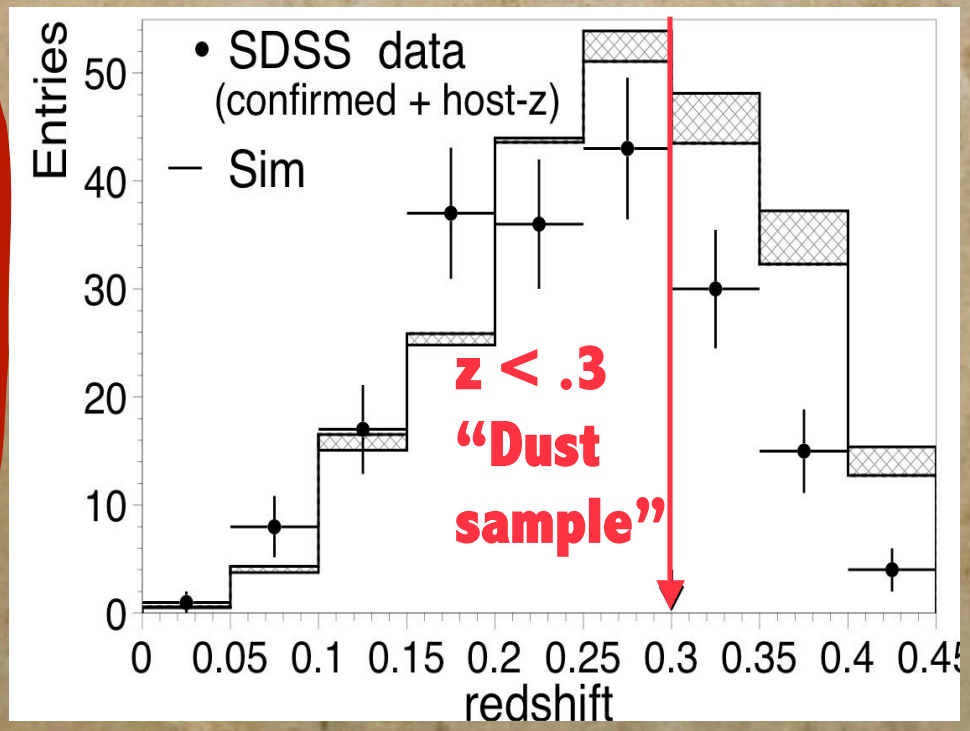
Confirmed SNe on average are BLUER and BRIGHTER than parent population → biased dust properties (R_V , A_V profile)

Measurement of Dust Properties with SDSS-II



PROBLEM: Spec-confirmed SN Ia sample has large (spectroscopic) inefficiency that is not modeled by the simulation.

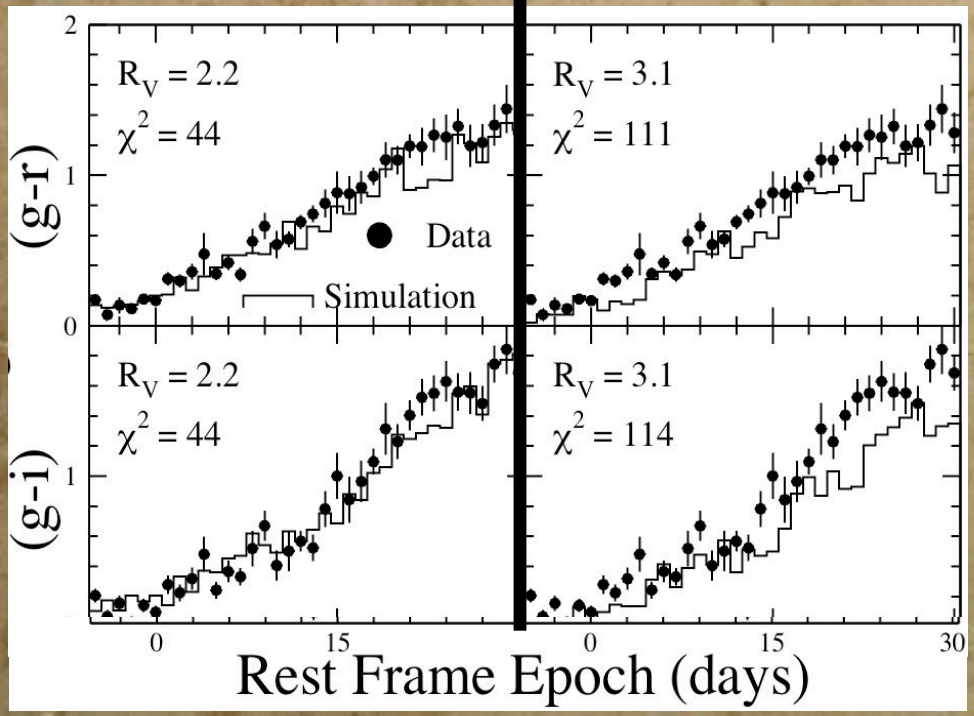
SOLUTION: include photometric SNe Ia with host-galaxy redshift: 155 with z < 0.3



Dust Properties with SDSS-II

$R_V = 2.2 \pm 0.5$ in simulation matches observed colors

$R_V = 3.1$ in simulation => Poor match



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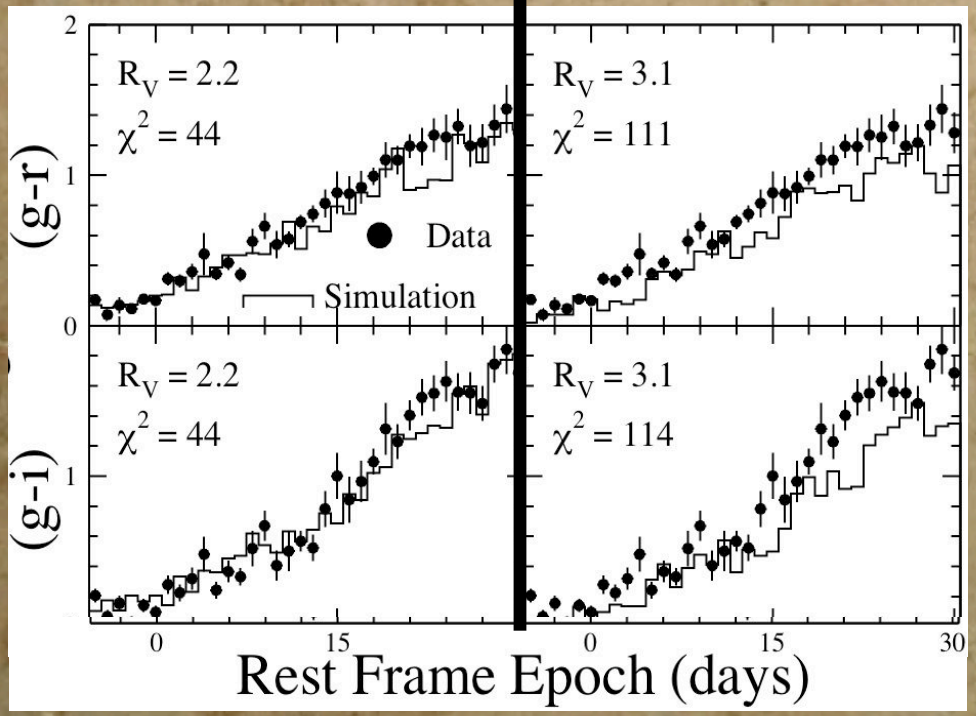
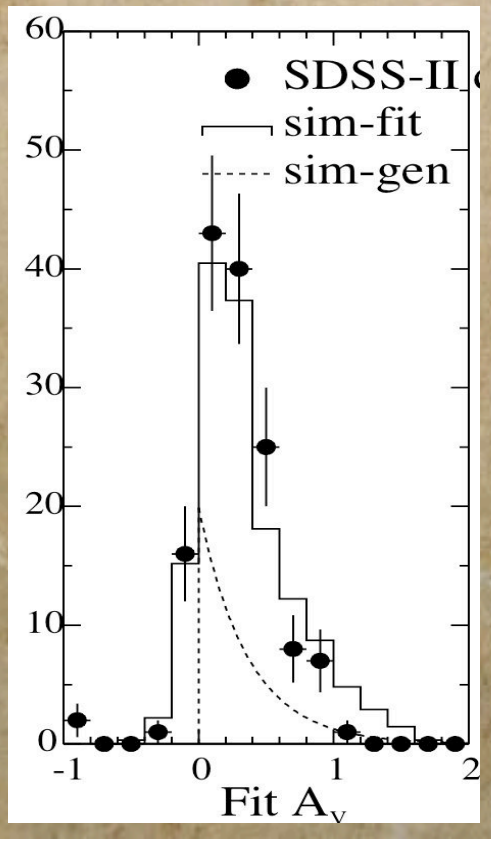
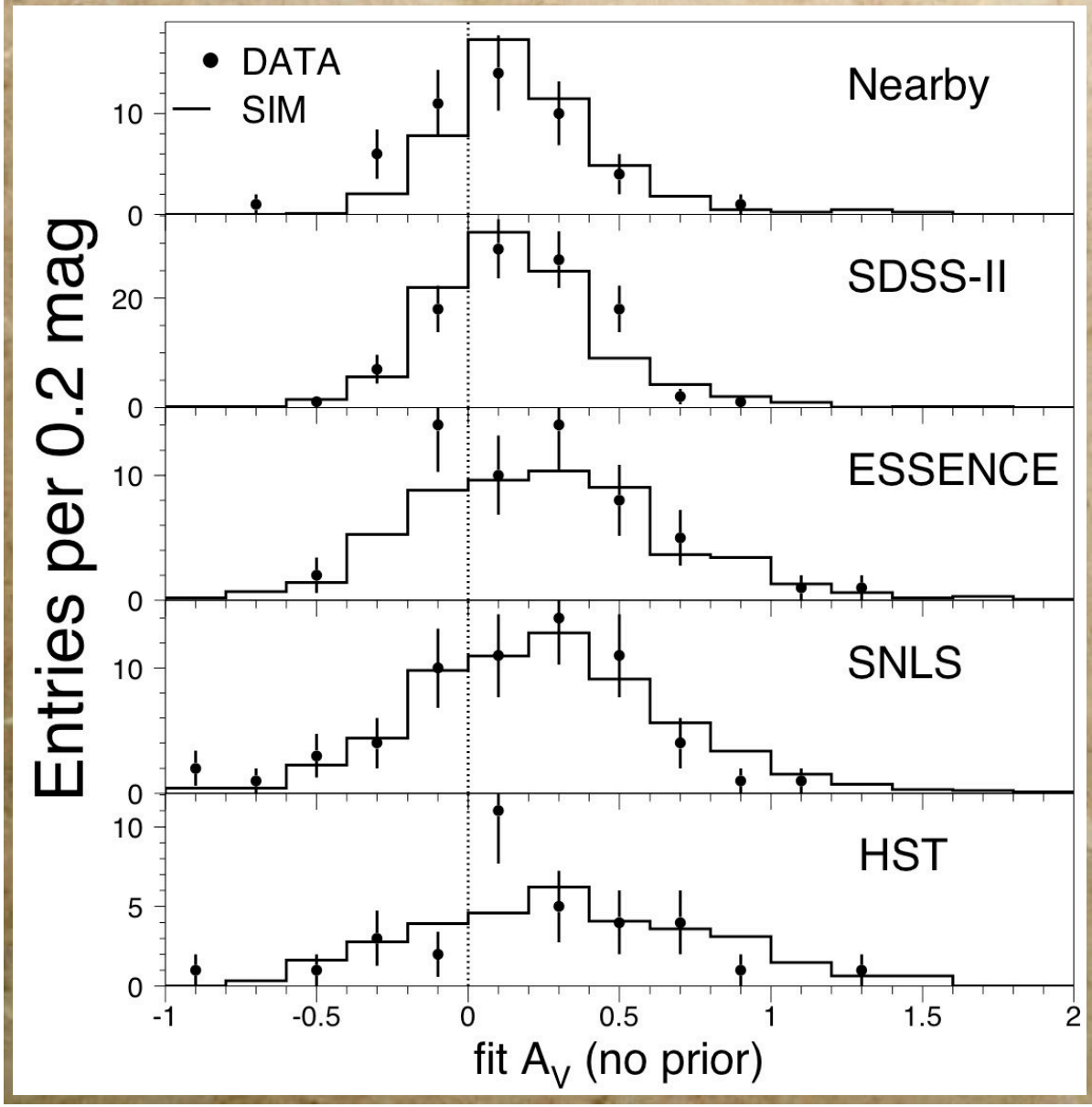


Exponential A_V profile in sim matches fit-A_V profile in data



A_V with Flat Prior



$A_V > 0$ generated in simulation

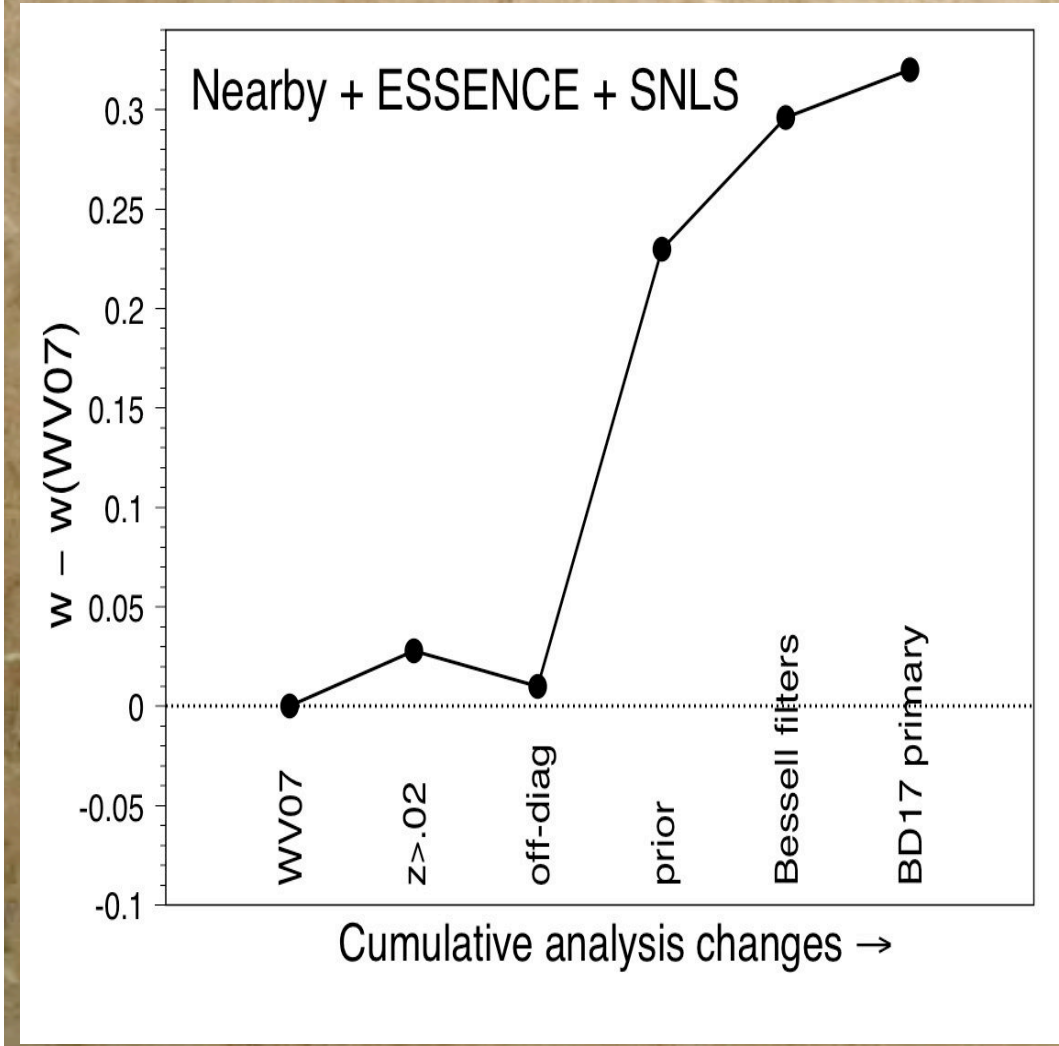
➜

describes fitted $A_V < 0$ with no prior

➜

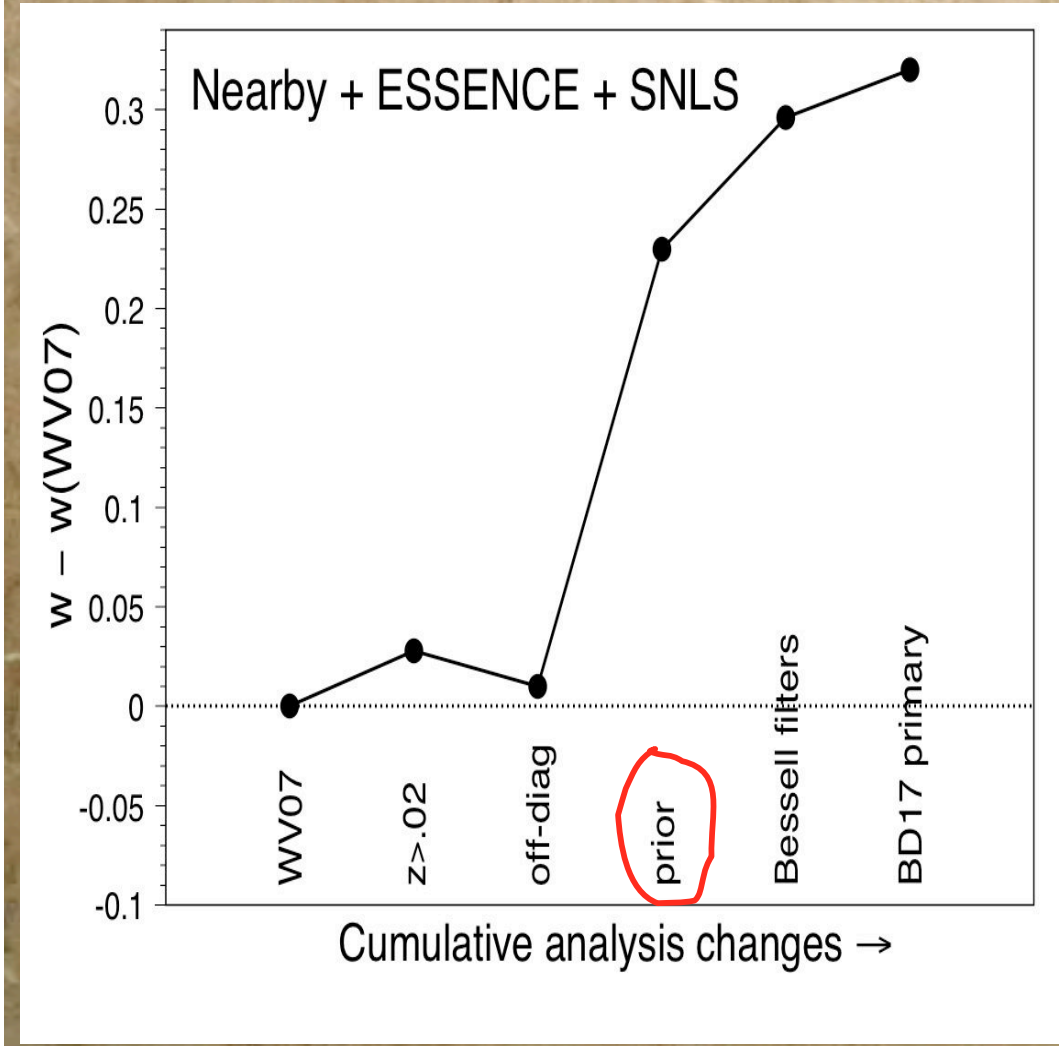
consistent with MLCS interp of too-blue SNe

Impact of MLCS Changes (δw ~ 0.3 compared to WV07)



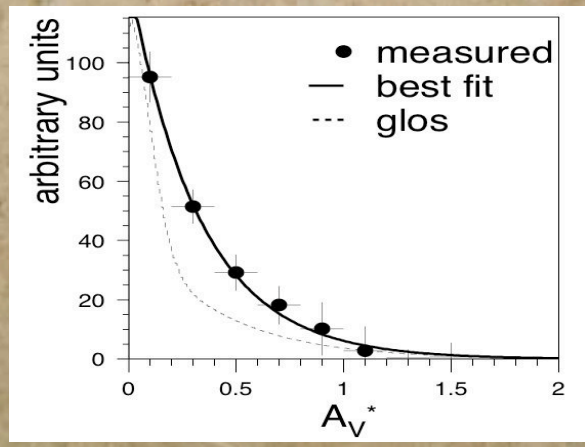
PREVIOUS MLCS -- BASED ANALYSIS FROM ESSENCE COLLABORATION

Impact of MLCS Changes (δw ~ 0.3 compared to WV07)



1. Measured R_V =2.2(5) (instead of assuming 3.1)

2. Measured A_V profile (instead of assuming glos)

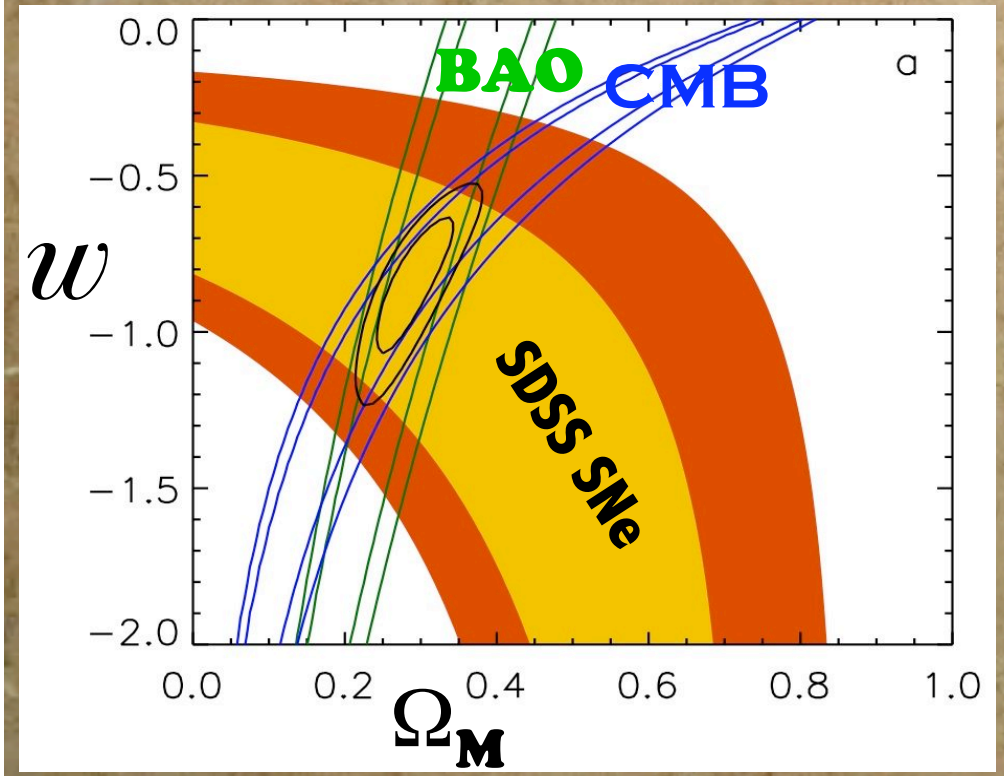


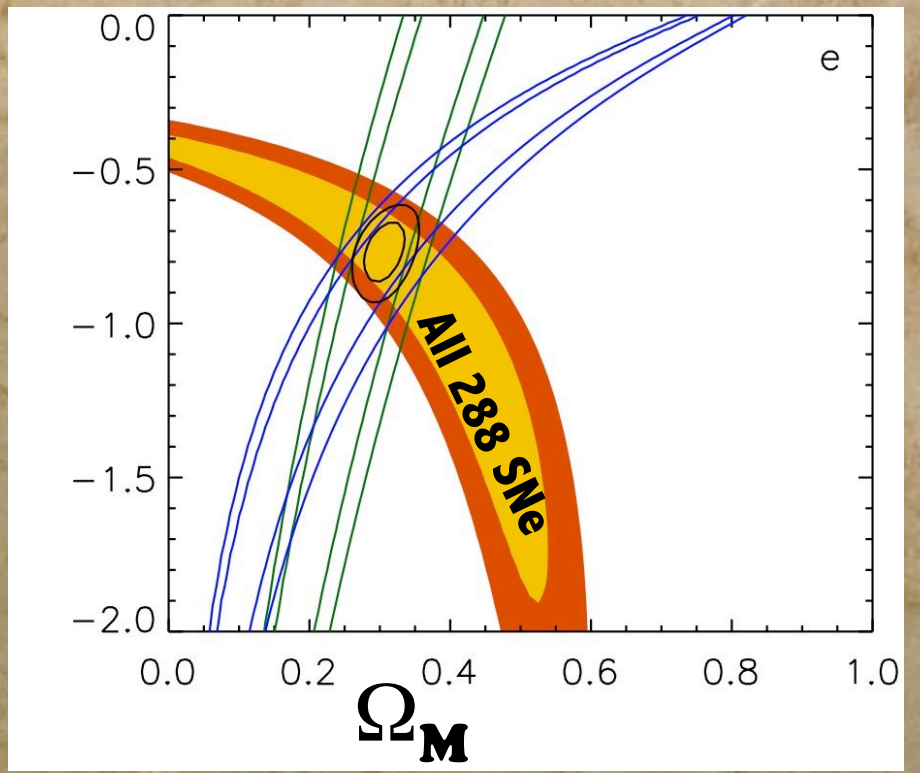
3. Include spectroscopic efficiency in prior (instead of ignoring it)

Cosmology Fit

- Priors: BAO, CMB, flat universe
- Float w and Ω_M

68% + 95% stat-error contours (MLCS)

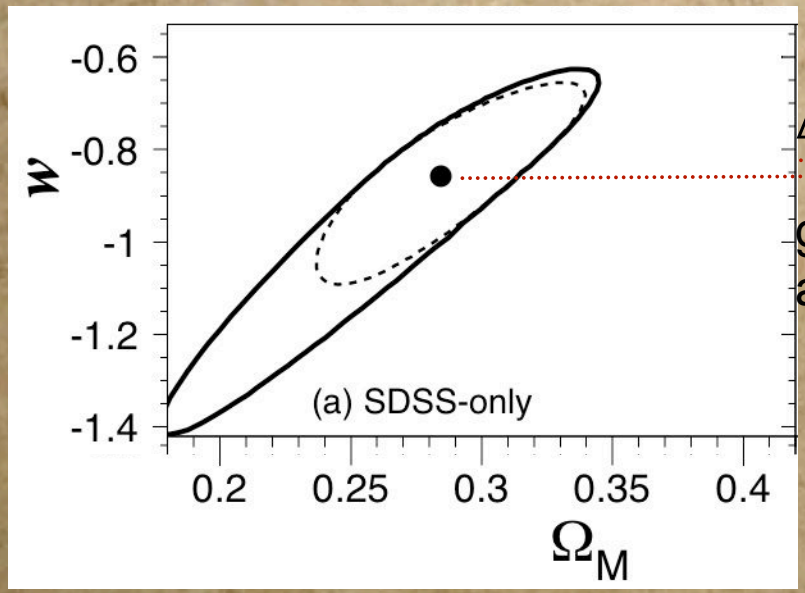




Preliminary

Results: — total error
-- stat error

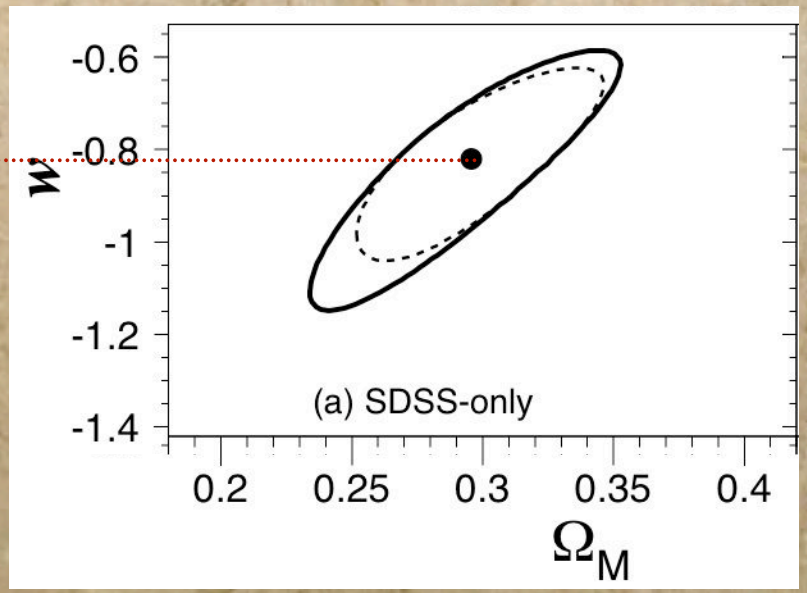
MLCS



Δw ~.04

good agreement

SALT-II



Preliminary

Results: — total error
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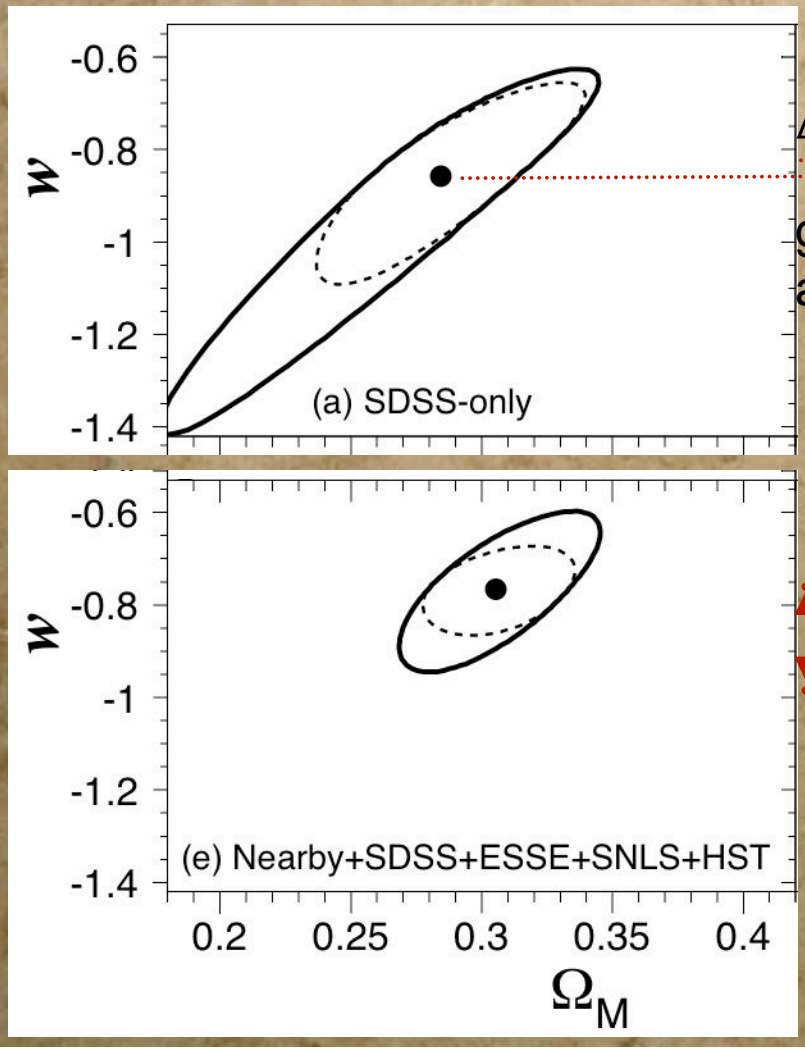
MLCS

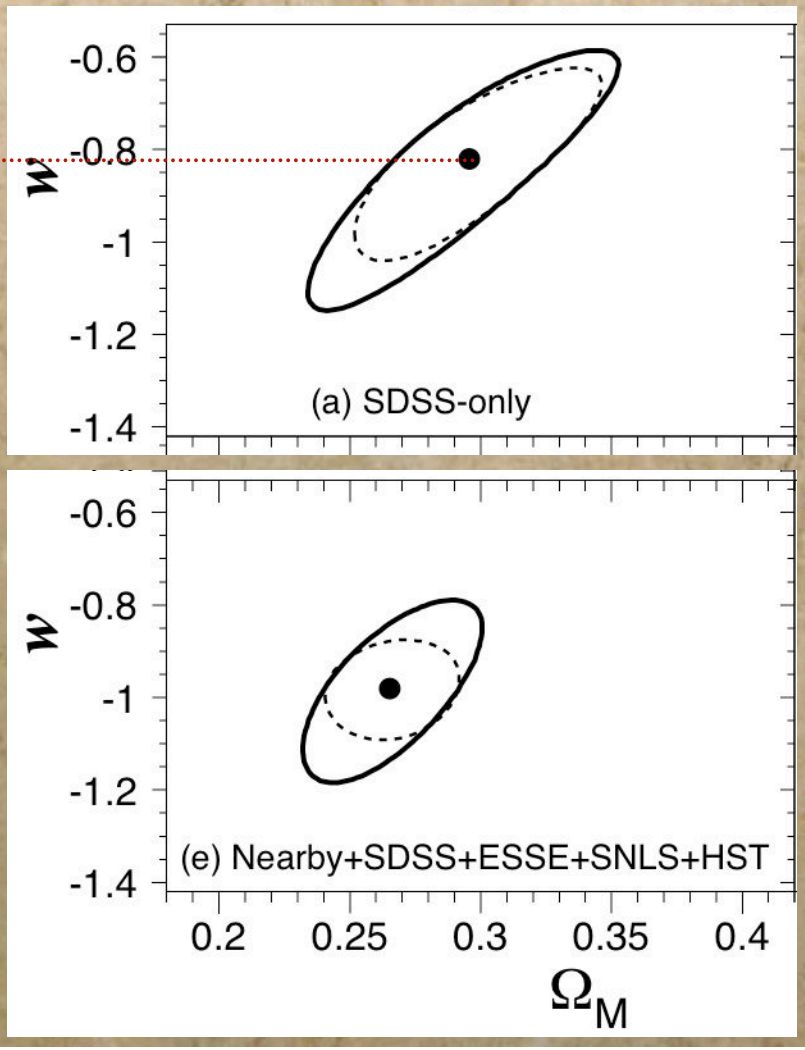


Δw ~.04

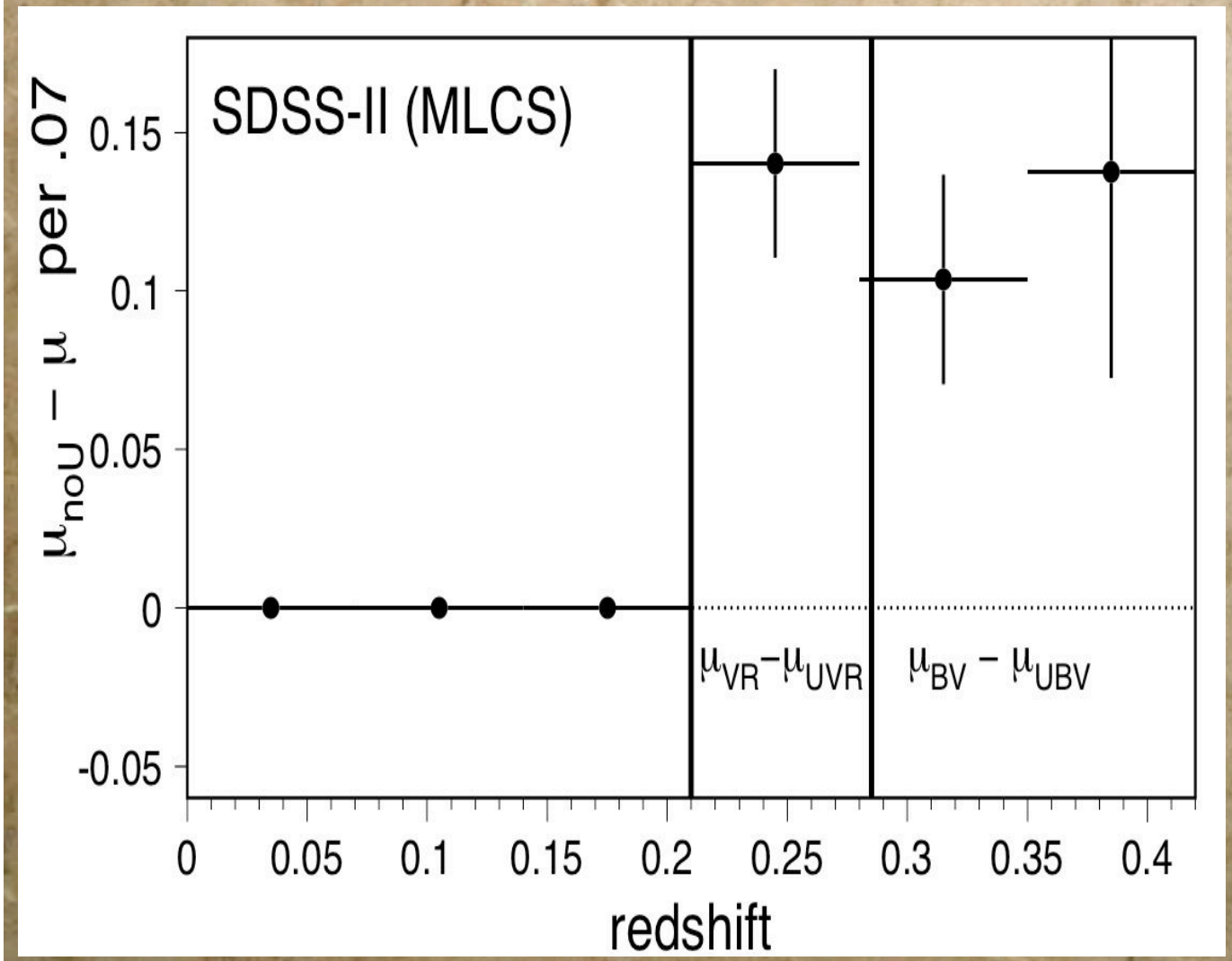
good agreement

Δw ~.2

SALT-II

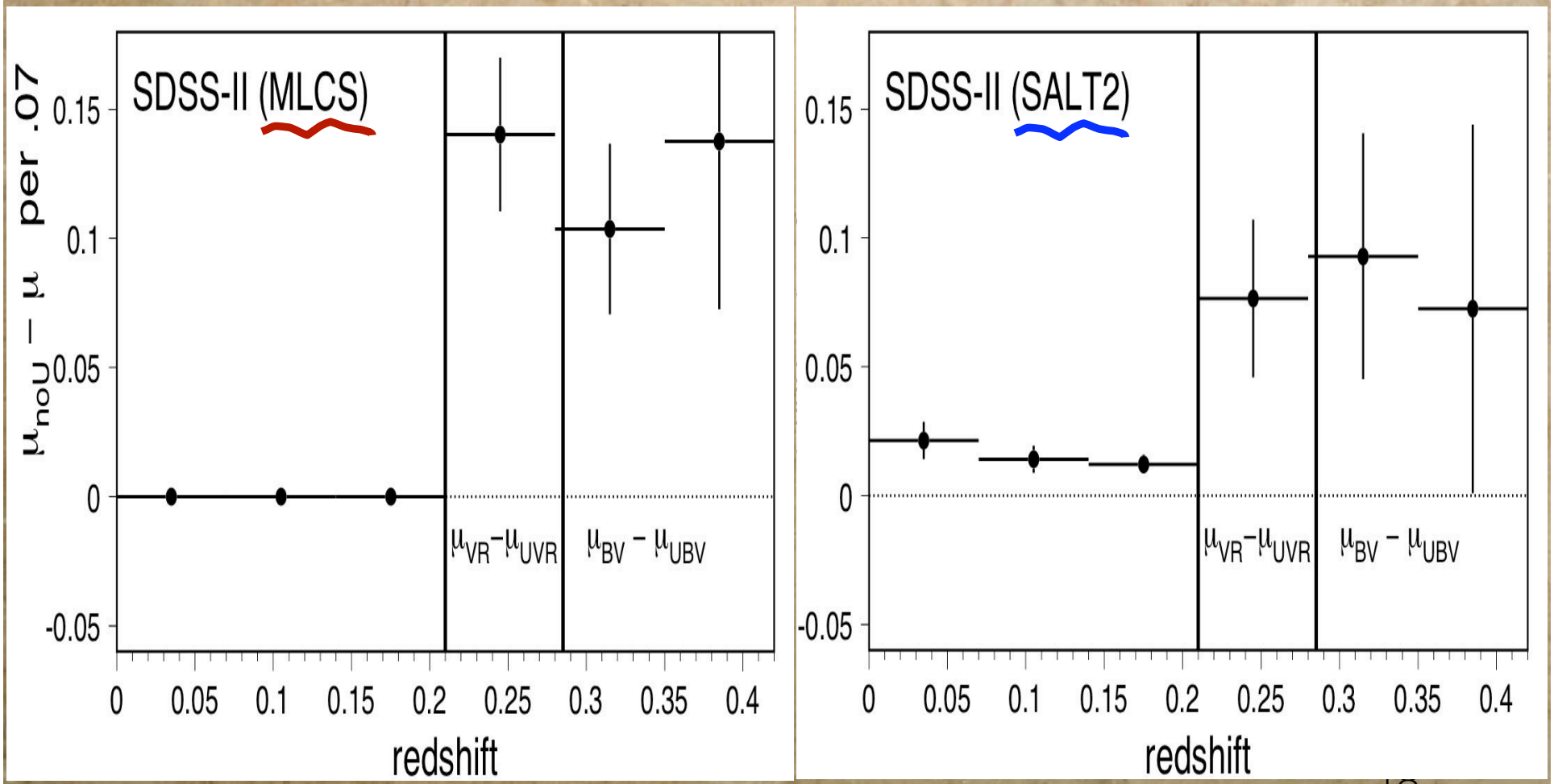


Large U-band Systematic for SDSS SNe



significance of shift: 6σ

Large U-band Systematic for SDSS SNe



SALT2-MLCS Discrepancy with/without rest-frame UV

SN sample(s)	$w_{SALT2} - w_{MLCS}$ for: Include rest-UV	exclude rest-UV
SDSS-only	0.04	0.25
All 5 samples (288 SNe)	0.2	0.1

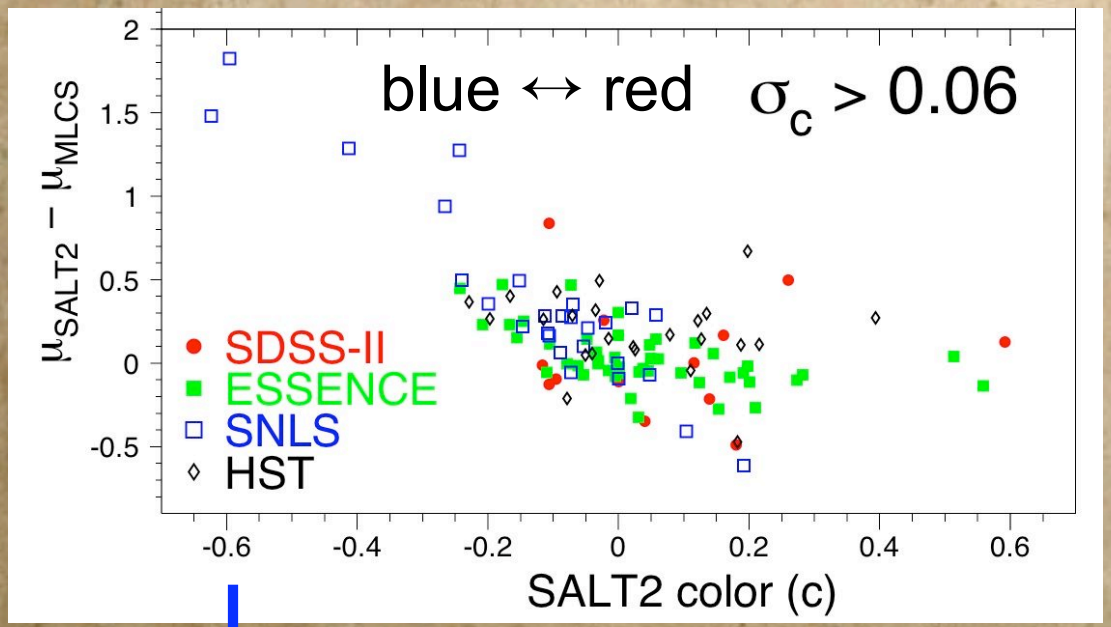
=> Include UV with large systematic error

UV-region

- Evidence points to problem with rest-frame UV in Nearby ($z < 0.1$) sample.
- MLCS is more sensitive (than SALT-II) to nearby UV because ONLY nearby SNe are used for training.

- SDSS SN sample ideally suited to study rest-frame UV region:
  - ✿ few dozen SNe with u → U ($z < 0.1$)
  - ✿ 200 SNe with g → U ($z > 0.2$)
  - ✿ with host-galaxy redshifts, perhaps double or triple !

MLCS-SALT2 Discrepancy (with high-z samples)



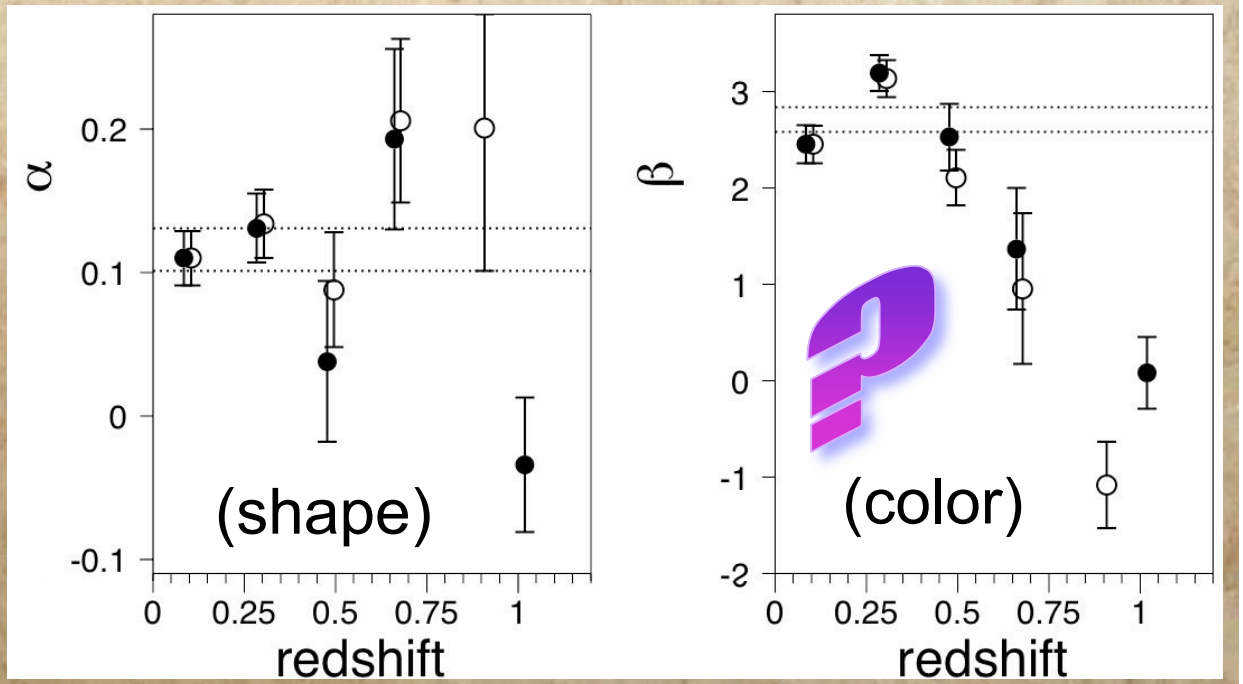
For really blue SNe:

SALT2 says they are brighter ⇒ larger μ

MLCS prior says can't be brighter than template with AV=0

SALT-II redshift dependence

Fit in separate redshift bins with cosmology (w,Ω_M) fixed to values from global fit.



- ● all five samples (e)
- ○ all except HST (d)

Summary

- Cosmology analysis of 1st season SDSS SNe Ia complete; paper under internal review.
- "improved" MLCS and "standard" SALT-II give discrepant results for w: (UV region and too-blue SNe)
- UV problem very clear with SDSS SNe ; dominates systematic errors.
- Still working to obtain a truly "complete" SDSS SN sample that includes photometric SNe with host-redshifts.

SDSS SN Papers

Published

- **Overview:** Frieman et al, AJ, 135, 338 (2008)
- **Survey:** Sako et al., AJ, 135, 348 (2008)
- **Spectroscopy:** Zheng et al., AJ 135, 1766 (2008)
- **SN Photometry:** Holtzman et al., AJ 136, 2306 (2008)
- **Lowz SN Rate:** Dilday et al., ApJ 682, 262 (2008)

Papers to be submitted in Jan 2009

- **Hubble Diagram & Cosmology:** K09
- **Exotic Cosmology Models:** Sollerman et al.
- **Low-z (z<.4) cosmology:** Lampeitl et al.,